Gas Phase Chromatography of the Bromides of Mo, Zr, and Nb

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The Heavy Element Volatility Instrument (HEVI)[1] has been used to investigate the volatilities of Mo, Zr, and Nb bromides. HEVI is an on-line isothermal gas phase chromatography system which separates short lived isotopes based on the volatility of their molecular form. The 8-min ^{88}Mo, along with multiple isotopes of Nb and Zr, was produced at the LBNL 88-Inch Cyclotron via the reaction of 86 MeV ^{28}Si projectiles with a ^{nat}Cu target. Reaction products were transported by a He/KBr aerosol gas jet system and continuously collected on a quartz wool plug kept at 900° C in a quartz chromatography column. HBr was added at a rate of 150 ml/min in order to form the volatile metal-bromide species, which were then swept into the isothermal section of the chromatography column. The separated species were then reattached to KBr aerosols and transported through a capillary into a glass wool filter placed in front of an intrinsic Ge gamma detector. ^{88}Mo ($t_{1/2}$ 8.0 m), ^{87}Nb ($t_{1/2}$ 2.6 m), and ^{85}Zr ($t_{1/2}$ 7.9 m), were identified by gamma spectroscopy, and the volatilities of their brominated forms were investigated by measuring the yields of these isotopes simultaneously as a function of the temperature of the column. Figure 1 shows the volatility data collected for the most prominent gamma line of each isotope. Volatility temperature is defined here as the point at which 50% chemical yield through the column is observed for that species; at this point the length of time spent in the column is equal to the half-life of the isotope studied. The apparent yield at low temperatures for these species seen in Figure 1 has been studied previously and may be due to mechanical transport through the column by undecomposed aerosols[3].

$^{87}NbBr_5$ was observed to be volatile at 150° C, and $^{85}ZrBr_4$ was observed to be volatile at 250° C. Preliminary data analyses shows no clear volatility temperature for the Mo species.

A Monte Carlo simulation program[2] was used to calculate the adsorption enthalpy of these species based on their volatilities. The adsorption enthalpy for $NbBr_5$ was calculated to be -100±5 kJ/mol. The adsorption enthalpy for $ZrBr_4$ was calculated to be –110±5 kJ/mol. Data analysis is still ongoing for Mo and so no adsorption enthalpy value has been calculated.

Footnotes and References

1. B. Kadkhadayan et al., *Nucl Instr. Meth.* A317, 254 (1992)
2. A. Türler, K. E. Gregorich, D. C. Hoffman, D. M. Lee, H. W. Gäggeler, Nuclear Science Division Annual Report, LBL-31855, p. 56 (1991).
3. E. Sylwester et al., Nuclear Science Division Annual Report, LBNL-39764, p. 61 (1995-96).

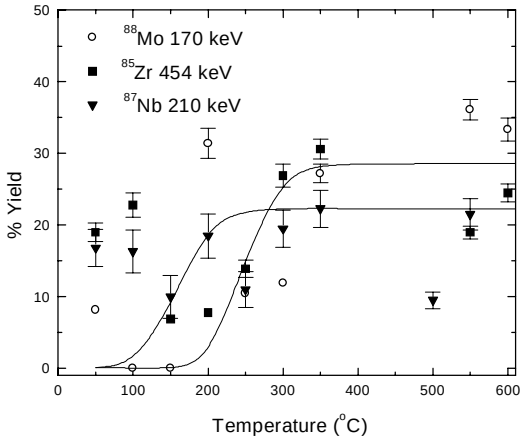

Fig. 1. Volatilities and calculated adsorption enthalpies for $^{88}MoBr_6$, $^{87}NbBr_5$, and $^{85}ZrBr_4$. The Monte Carlo curves shown are the best fit to the data. No adsorption enthalpy curve has yet been calculated for Mo.